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A BOX EJECTOR FOR INSECT DISTRIBUTION FROM A HELICOPTER

By P. A. Boving, R. G. Winterfeld,[1/] B. A. Butt,[2/] and C. E. Deonier[3/]

SUMMARY

An ejector mechanism for opening and ejecting boxes of sterile codling moths over infested orchards was constructed, mounted on a helicopter, and used successfully over a 93-acre test orchard. The ejector is a modification of the one developed by the U.S. Department of Agriculture for use in the screw-worm eradication program.

In flight, absorbent paper boxes (2 by 4-1/2 by 5-1/2 inches) enclosed the sterile moths and held them during the initial rapid deceleration. Deceleration occurring after the boxes opened did not appear to injure the moths.

STATING THE PROBLEM

Studies by entomologists [4/] indicate that several insect pests can be controlled by releasing sterile males over the breeding areas of the natural insect pests.

In field tests of sterile insect releases, the area to be covered is often too large or too awkward to travel through on foot or by ground equipment to distribute the sterile insects. In mature orchards where the tree limbs grow close to the ground, vehicular traffic between the rows is difficult, and the practice of propping heavily laden branches adds to the problem of access. Irrigation practices also prevent the use of ground vehicles for distributing the sterile insects; foot traffic is not practicable.

1/ Agricultural engineer and aircraft pilot, respectively, Agr. Engin. Res. Div., ARS, USDA, Forest Grove, Oreg.

2/ Entomologist, Entomology Res. Div., ARS, USDA, Yakima, Wash.

3/ Entomologist, Entomology Res. Div., ARS, USDA, Forest Grove, Oreg.

4/ Baumhover, A. H. Eradication of the screw-worm fly, an agent of miasis. Amer. Med. Assoc. Jour. 196: 240-249. 1966.

Since insects are subject to some injury when released in boxes from fixed-wing aircraft [5/] flying 85-150 m.p.h., and since the codling moth is a fragile insect, a helicopter flying 45-50 m.p.h. was selected for releasing them. Sterile codling moths were released from a helicopter in 1967. [6/]

Aerial release of sterile insects is an important phase of the codling moth control research for several reasons. A control program requires timely airborne release over total infested acreages. Frequent clusters (200 feet apart) or the continuous release of sterile moths is necessary for the control of the wild population because the moth is a relatively weak flier. Also, as stated, infested areas are easier to reach by aircraft than by any other means.

REVIEW AND ADAPTATION OF EXISTING EQUIPMENT

The box ejector developed by USDA for use in the screw-worm release program at first appeared to meet the requirements for field testing the control of codling moths in the Yakima, Wash., area. A set of plans was obtained from the Southwest Screw-Worm Eradication Program, Animal Health Division, ARS, USDA, Mission, Tex.

In the screw-worm program, the ejector was used to release the boxes of flies from fixed-wing aircraft and some physical damage to the released flies was noted. In view of this and since the codling moths are more fragile insects, a modified box ejector was built [7/] for use on a helicopter.

Boxes used measured 2 by 4-1/2 by 5-1/2 inches, and were formed from a stamped sheet of kraft cardboard. Locking tabs held the sides in place and a cover, brought over the top, locked in front. The boxes were filled with irradiated mature moths, and paper excelsior for padding, and were metered by a feed chain to force them under a roller which released the lid locks. The boxes then dropped through a chute to a venturi outside the aircraft fuselage where the violent airstream action completed the box opening. The magazine of the ejector held 13 boxes when full. During flight, a technician kept the magazine loaded from a stock of boxes carried in the helicopter cabin.

5/ Steiner, L. F., W. C. Mitchell, E. J. Harris, T. T. Kozuma, and M. S. Fujimoto. Melon fly eradication by overflooding with sterile flies. Jour. Econ. Ent. 58: 519-522. 1963.

6/ Butt, B. A. Recent progress in the release of sterile codling Moth. Washington State Hort. Assoc. Proc. 63: 15. 1967.

7/ The box ejector was constructed with the able assistance of Lee E. Stevens and Walter C. Wilson, machinists, and John D. Foss, laboratory helper who made the engineering drawings. Plans for the ejector, as modified for release of sterile codling moths, may be obtained from the Agricultural Engineering Research Division, ARS, USDA, Forest Grove, Oreg.

In the codling moth release, the paper boxes were used for release only, whereas in the screw-worm program, irradiated pupae were reared in the boxes. When the flies hatched, the boxes were released from aircraft. Some of the flies became airborne while the boxes were falling and the remainder left the boxes after impact with the ground.

The litter problem resulting from a single season's use of these boxes was considered minor since the releases were experimental. Research is continuing on direct release methods that will eliminate the box litter.

By mounting the ejector outside the helicopter cabin, a discharge chute through the cabin floor was eliminated, and the boxes followed a simple flow pattern through the ejector mechanism. This change resulted in more space in the cabin and facilitated the transfer of the ejector from one helicopter to another.

CONSTRUCTION OF THE EJECTOR

As shown in figure 1, the modified ejector consisted of the following components. A vertical magazine held the boxes until a pusher plate forced them to the lid-opening device at the rear and onto an endless chain metering device. The chain was driven by an electric motor. A speed controller adjusted the chain's speed to eject from 0 to 10 boxes per minute.

The ejector assembly weighted 18 3/4 pounds; aluminum was used wherever possible to reduce the weight. The motor and transmission were mounted as a single unit in front of the metering device to permit the use of different shaped magazines and to provide greater mechanical strength for the metering drive device.

MOUNTING THE EJECTOR

The size of the helicopter door opening, the cabin outline, and the landing skid configuration on the right (passenger) side of the helicopter were the deciding factors for locating the metering portion of the ejector below the floor height of the cabin. A mounting harness was designed and suspended from the forward landing-skid member and braced to the vertical leg. Semicircular sections of steel pipe rested on the member and were clamped on with hose clamps. The steel-pipe harness, welded to these sections, provided a platform alongside the cabin on which to support the ejector mechanism (fig. 2). The harness weighed 9 1/4 pounds.

TESTING AND MODIFYING THE EJECTOR

After flight tests the box ejector was further modified to improve its performance. The ejector was moved as close to the open door of the cabin as possible, and wind shielding (fig. 3) was added to protect the ejector from the strong updraft alongside the cabin. A draft plate (fig. 4) was installed behind the ejector to reduce the effect of the dead air wake.

Figure 1.--Box ejector and mounting frame, without shielding.

Wedge openers were added behind the regular opening wheels to insure opening of the boxes. In tests using fixed-wing aircraft, the greater forward speed (100 m.p.h.) helped to open the boxes. The wedges and the pusher bar on the timing chain caused the boxes to twist upward behind the ejector and away from the influence of the draft plate. Piano wire spring guides were installed to hold the boxes down in the airstream caused by the draft plate.

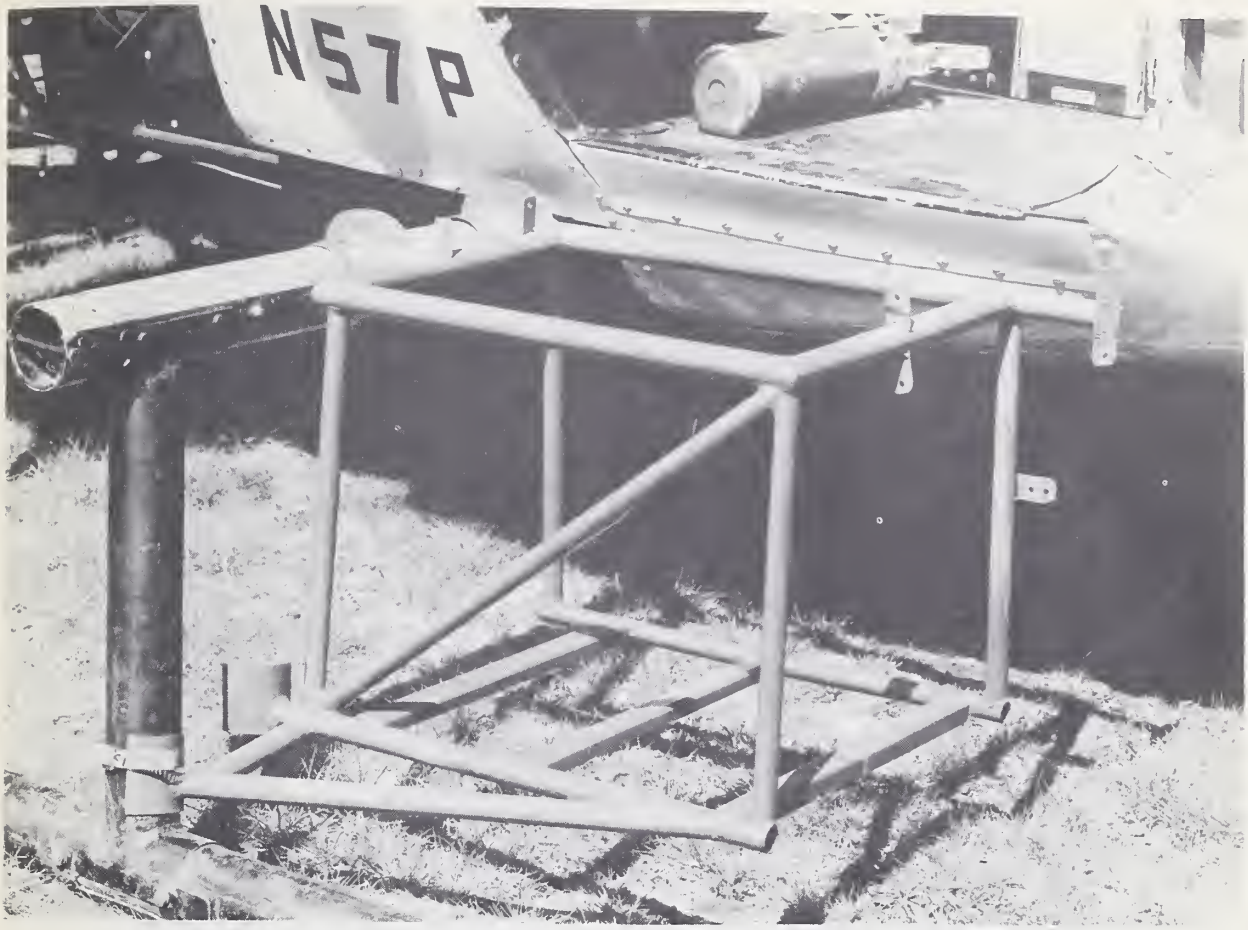

Figure 2.--Mounting harness for box ejector

The draft plate and shielding together weighed 3 1/2 pounds. The total unit weighed 31 1/2 pounds.

RESULTS

At airspeeds of 45-50 m.p.h., the boxes containing the sterile codling moths were ejected uniformly, the frequency of their ejection having been set by the speed control transmission. The boxes left the ejector with their lids released by the opening wheels and wedges. At a point approximately below the tail rotor, the boxes opened fully, disgorging their contents of paper excelsior and moths. Thus, there was a short period when the box and contents fell together before the contents were spilled out.

Figure 3.-- View from the front of the helicopter, showing test shielding in place and proximity of ejector to helicopter cabin.

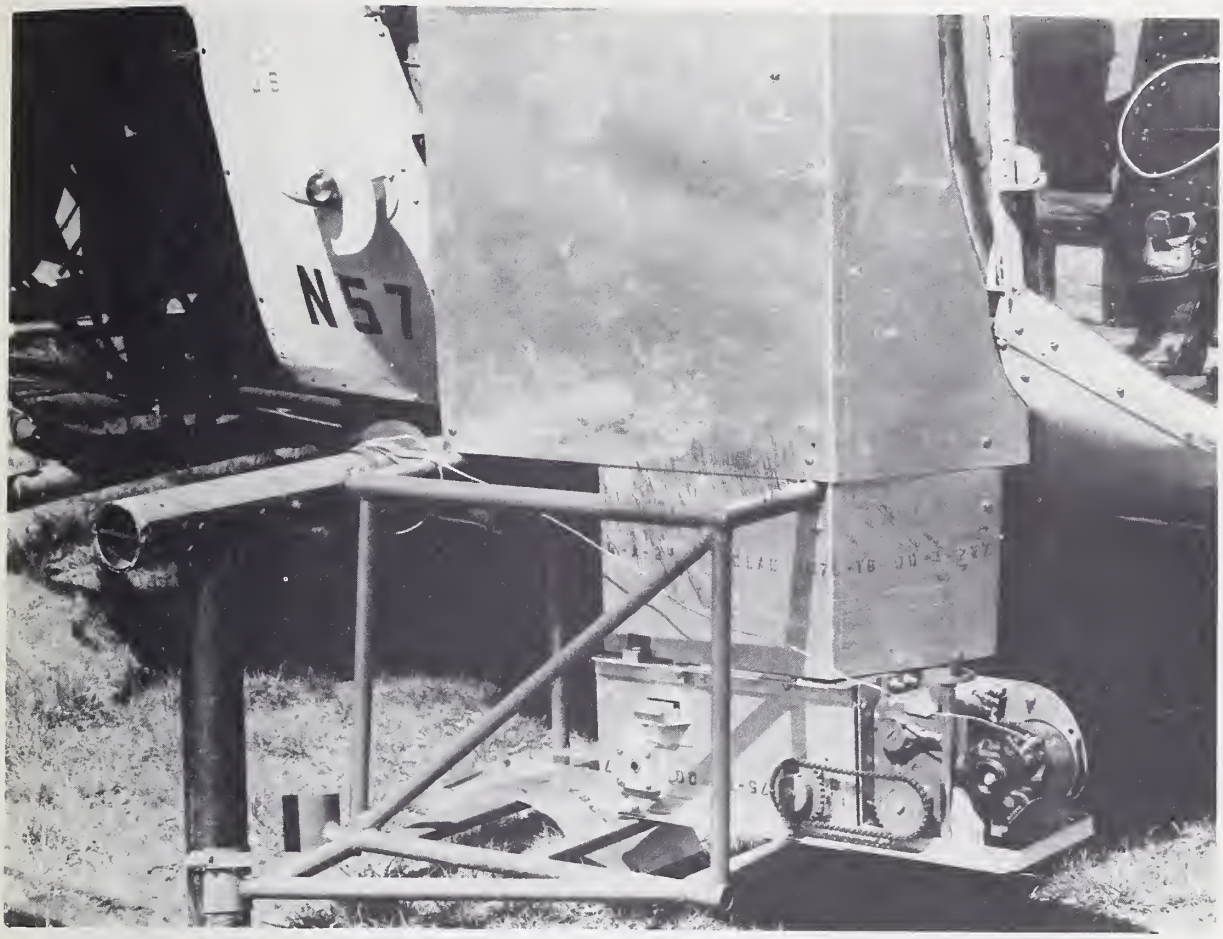

Figure 4.--Box ejector in mounting frame with permanent shield in place. The draft plate can be seen behind the ejector.

In flight, the boxes enclosed the insects and held them during the initially rapid deceleration. Deceleration occurring after the boxes opened did not appear to injure the sterile codling moths.

A mortality test conducted at Yakima, Wash., compared boxes of moths recovered after being ejected with control boxes of moths not ejected. Results were as follows:

	Boxes ejected	Control boxes
Date of release	4/18/67	4/18/67
Date of analysis	4/21/67	4/21/67
Percentage of mortality	22	22
No. of boxes tested	9	9

Boxes were held at 80°F. for 48 hours between recovery and analysis.

From April 7 to September 26, 1967, a 93-acre apple orchard was treated with sterile male and female codling moths distributed by a helicopter equipped with a box ejector. Nineteen traps, baited with female moths, were placed throughout the orchard, and the catch was average 537 native males to 33,557 sterile males for a ratio of 1:62. Fruit damage at harvest-time for this orchard and adjacent control blocks was as follows:

Location	Damaged fruit
	Percent
93-acre test orchard	0.26
Untreated plot, 3/4 miles away (harvested June 30)	39.8
Average damage for sprayed orchards in area	.24